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Factsheet

DRAIN PROBLEMS

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RECOGNIZING A PROBLEM

Regular maintenance of a drainage system including inspection of the surface of the drained area, will reduce problems to a minimum. In the spring, note the dry streaks created by each drain and check for wet spots over the drain. Look for two things:

(a) Wet spots that remain after the rest of the field has dried off.
(b) Holes in the field caused by soil washing into the drain.

Check whether the outlet has eroded, discharge is free and the rodent guard is in place. Clean any grass and debris that may have collected behind the grill. Look below the outlet for signs of red iron, long green stringy organic waste, or signs of sand coming from the drain. Should any of these problems occur dig up the drain at critical points and examine it. If there is a problem, call your drainage contractor.

TYPE OF PROBLEMS

The failure of subsurface drains to perform as expected may be caused by:

1. Soil physical conditions not permitting drainage.
2. Not determining the source of the water before the drains were installed.
3. Construction when soil too wet.
4. Grade reversals in construction.
5. Breakage, or improper alignment of drain tile or damage to plastic tubing through careless back-filling.
6. Settlement of sections of drain because of an unstable foundation.
7. Excessive crack widths between drain tile, or excessively large slots in plastic tubing, or perforations improperly cut, which allow soil to enter the drain pipe.
8. Erosion of soil into the drain pipe because of loose backfill.
9. Ochre clogging.
10. Improper envelope material or application, that is, poor placement, tearing of envelope material, sealing of envelope with soil or ochre.
11. Collapse of drain pipe because of excess surface load, weak pipe or improper backfilling methods.
12. Plugging of pipe by organic wastes, and roots.
13. Certain types of plastic may be adversely affected through brittleness and cracking by surfactant chemicals, therefore, milkhouse wastes should not be permitted to enter a corrugated plastic tubing.

Drain problems can be confirmed through simultaneously observing the drain discharge and the height of the watertable between drains.

SEDIMENTATION

The effectiveness of a drainage system may rapidly be destroyed through soil entering the drain pipe. Some soils have a greater tendency toward sedimentation than others. Soils of uniform grain size are unable to form a natural soil filter. These soils have been identified as very fine sands, loamy fine sands, fine sands and silts as well as some organic soils. Such soils are unstable when saturated and will flow into the drain pipe or seal and block the entry of water into the pipe. All soils with structural instability create low soil permeability.

The upward force of water entering a drain pipe may exceed the buoyant soil particle weight and result in instability and soil movement unless natural bridging occurs. Particles longer than 0.25 mm generally have enough mass to withstand the usual forces produced by soil water flow and tend to be stable.

Instability would be greater for fine silts and clays except these soils exhibit cohesive inter-particle forces which bind them together. The critical tractive force must be exceeded for a particle to move. Intermediate diameters move at lower values of tractive force. Fine-grained soils (diameters less than 0.05 mm) will not require an envelope and do not form long-term deposits in drain pipe. Indeed, these soils may clog an envelope material if one were used.

Figure 1. Apparatus for pipe envelope test

TESTS FOR ENVELOPE NEED

Soils with a high degree of non-uniformity are not subject to sedimentation. Fine-grained soils with a uniformity coefficient, U, of less than 5 are susceptible to sedimentation, which is, $U = d_{60}/ d_{10}$ less than 5, where the d_{60} is a fine or very fine sand. The d_{60} refers to the diameter of the material of which 60% is finer from the grain size distribution curve. In the Unified Classification, soils requiring drain envelope materials are: SP, SM, ML, and MH. Another common criterion is that envelopes are required for soils where the plasticity index, PI, is less than 10.

Once the grain size distribution has been determined, graphs are available for establishing the effectiveness of an envelope for a particular soil. At the same time, the Atterberg Limits for the soil must also be determined in order to make a proper classification to assess the appropriateness of an envelope.

A simple test to determine the need for a filter envelope for a particular soil can be made as follows:

Cut the top and bottom out of two metal coffee cans, solder the cans together so you have an open cylinder about 280 mm (11 in.) high and 100 mm (4 in.) diameter. Cut the centre from the plastic lid to leave a 10 mm retaining ring. Fit a circular piece of stiff screen, 100 mm (4 in.) diameter in the plastic retaining ring. The openings in the screen should be 2 to 3 mm. Place on the can. Take a sample of moist soil from drain depth. Place the test can on a flat surface and gently place a sample of the soil on the screen in the can. Using a wooden stick not less than 25 mm (1 in.) in diameter, tamp the soil to the same density as the parent soil and to a depth of 25 mm (1 in.). Raise the can off the flat surface by placing it on two thin sticks of wood. Slowly and carefully pour water into the top of the can being careful not to erode or wash the soil. Add water to a depth of 185 mm (7 in.). If the water and soil does not wash out the bottom after it has been left undisturbed for 15 minutes, the drain pipe probably does not require a filter envelope.

SOLUTION

Construction Deposition of soil particles in a drain pipe usually takes place immediately after construction when the backfill is still loose and any pre-existing soil structure has been destroyed. In many instances, the material found in the drain pipe may be coarser than the parent material because of fines being washing away.

Self-cleaning drain grades are not feasible in unstable soils. Minimum grades for full pipe flow are recommended in the Ontario Ministry of Agriculture and Food Publication 29, *Drainage Guide for Ontario*, but such grades do not make allowance for conditions of excess sediment loads in drains. Drains will not flush out naturally when the depth of sediment exceeds 20 mm.

Drains in unstable soil should be designed for the maximum grade available. Drains should be placed at minimum depth. Do not connect drains which will carry sediment to main drains — try to develop separate outlets for the each problem drain.

It is essential that construction in these problem soils take place during dry periods, otherwise problems are certain to occur. Initial installation is a very critical period.

Insoils requiring envelope filter protection, and where large main drains are specified in the design some economy may be available if the main drain is of non-perforated corrugated plastic tubing. A 100 mm drain, protected with an envelope filter may be laid parallel to the main drain.

Envelopes When labor was available and inexpensive, drain pipes were blinded with sod which created an effective filter envelope by placing water stable particles near the drain pipe. It also increased the effective pipe diameter and reduced the velocity of inflow. In Europe, sieved Sphagnum peat moss or peat band is used with success. Straw has been used in Ontario but has only a temporary effect and may seal the water openings. Graded gravel envelopes are also used with success in western Canada but these are very expensive in the areas where filters are required. There is also substantial promise in the use of bituminous emulsion, polmerized acrylamide (PAM) and other soil conditioners in stabilizing a 4 cm thick envelope around the pipe in the backfill. The method of application needs to be resolved.

It is not practical to design a manufactured envelope for a narrow range of grain sizes. A conservative stability criteria giving protection in the critical size range is that the 50% size of the grain size distribution curve is not greater than the average diameter of opening of the filter. The average opening of fibreglass is 0.15 mm, so if $d_{50}/ 0.15 = 1.0$ then the d_{50} is 0.15 mm.

The types of envelope material now available in Ontario provide protection for most problem soils provided the soils do not contain a large proportion of fines. Failures of envelopes may occur through sealing by fine silt and clay particles and by iron and manganese oxides and sulfates. They also fail by mechanical tearing and abrasion. Roll envelope materials rely on good field installation for good performance.

Filter material is affected by the weather and deteriorates in storage. Filter wrapped drainage pipe should not be stored outside for more than 6 months. Heat generated within maxi-coils adversely affect the life of the filter. Such coils should be installed as soon as possible. Storage in wet conditions may promote fungus growth on filter material.

OCHRE

Reduced iron in solution in the soil and groundwater oxidizes on entering the drain pipe and a sludge of iron hydroxide gradually clogs the pipe. The deposit begins at the invert of the joint between two drain tiles and may possibly build up and seal it all around. In plastic tubing, it plugs the holes and also seals any type of manufactured filter material. It can be recognized as a rusty red deposit at the outlet. Limited success has been achieved in flushing drains with a 2% solution of sulfur dioxide gas where the drain can be kept full of the solution for a period of time. This red precipitate or "jelly" is a widespread problem in sands.

Ochre clogging of drain pipe is a biochemical process. There are two forms of ochre deposit which block the entry of water into drains: (a) bacterial clogging and (b) chemical clogging. They usually occur simultaneously.

Soils with substantial iron and filamentous red ochre deposits will continue to form iron clogging indefinitely. Where the pH is above 5.5 the ochre problem is likely to abate some time after the drains have been installed. This iron is due to bacterial origin.

Ochre occurs in two classes of soil: (a) very open soil such as acid sands, and (b) those in bottom land with perennial groundwater. Organic matter from root systems dissolve in groundwater and produce anaerobic conditions making iron ochre soluble in drainage water. The ochre comes out of solution, or precipitates in air. Iron will be deposited at outlets, obstructions, changes in direction, junctions, and where water enters the pipe, i.e. wherever flow velocities decrease or the water is aerated. Black gelatinous iron sulfide FeS sorbed on organic matter forms on the envelope. It is unclear where the problem starts to form.

Ochre is a world-wide problem; there is no known cure for severe ochre problems. In as much as the problem is caused by changing chemical conditions within the soil profile, all kinds of pipe materials are subject to clogging by iron oxide deposits. In some instances, copper wire in the drain, submerged drains and large diameter porous envelopes which make the ochre form away from the drain pipe have been used. It is reported that organic envelope material, such as straw or wood chips, delays the formation of ochre. Soil backfill treated with lime CaO (1% or 4 to 5 kg of CaO per meter) has been successful in preventing iron clogging and in creating water stability in finer textured soils. Other recommendations have been reduced spacing, larger diameter pipe, short laterals, maximum grades.

On present knowledge, there are no obvious comprehensive solutions worthy of field trial. The problem may be insolvable in terms of being both economically viable and compatible with farming the land.

For further information see Ontario Ministry of Agriculture and Food Factsheet, *Iron and manganese oxides problems in tile drains,* Agdex 752.

ORGANIC WASTES

Organic waste, such as liquid manure improperly applied, cause failure in drains in a very short time with the result that the affected parts of the system must be replaced. Milkhouse wastes and washings when permitted to enter a drain forms a live gel which very rapidly completely fills the pipe.

Catch basins and even lateral drains near feedlots and barnyards allow manure liquids and straw to enter the drain pipe. These form long, stringy, stinky, masses which fill the drain pipe. They are white when washed with water. Even when large-diameter pipes are dug up, it is difficult to remove this type of material. A similar type of material is formed in the pipe when wet barnyard wastes, together with gutter washings, keep the drain wet and roots from clovers and grasses penetrate the pipe, collect the wastes, and plug the pipe.

Chemicals must never be allowed to enter the drain system as they will harm the natural environment at the outlet.

A drainage system is a major capital investment for the drainage of fields; never allow water containing any nutrients and organic wastes to enter it.

CLEANING OF SUBSURFACE DRAINS

Low pressure (480 kPa) jet cleaning of 100 mm drain pipe up to 175 m in length has been successful when deposits are mainly ochre and FeS. In sandy areas, jetting should take place soon after the deposit takes place. The discharge rate required is about 75 litres per minute.

High-pressure pumps (8,300 kPa) have been successful in removing some sands from drains. However, in most instances it usually only levels the deposit.

ROOTS IN DRAINS

From time to time a drain may plug or become less effective because roots of trees, shrubs or crops enter the drain pipe in search for water. The problem is usually associated with drains that continue to run water or remain wet during dry weather because of springs or waste water.

The problem may be prevented through the use of non-perforated corrugated drain tubing or sealed drain tile in a troublesome area, or removing the source of the roots. Where it is a general problem the laying of a bare copper wire adjacent to the drain pipe will often control the roots. The same method has been suggested as being effective in the control of ochre in some sites.